DIVISION 7
CONCRETE PAVEMENTS AND SHOULDERS

SECTION 700
GENERAL REQUIREMENTS FOR PORTLAND CEMENT CONCRETE PAVING

700-1 DESCRIPTION

The Specifications provide for the use of any reasonable equipment or methods which will produce acceptable work. The Specifications further require inspection and approval of the Contractor's equipment by the Engineer prior to the beginning of work. The Engineer should contact the Pavement Construction Section of the Construction Unit to request assistance prior to this inspection and approval.

The Specifications require that all equipment be maintained in satisfactory operating condition. Frequent breakdowns may be a reason for the Engineer to shut down paving operations until the equipment is operating satisfactorily. It may be impractical for the Engineer to actually detect the operating condition of the various pieces of equipment until paving has begun. Therefore, when it is known that the Contractor's plant or roadway equipment has recently been on another highway project in the State, the Engineer on the previous project should be contacted and the performance of the equipment discussed to detect operating characteristics, potential problem areas, etc.

Due to the many variables in production and placement of concrete pavement and due to the difficulty of repair or replacement of faulty work, this type of pavement demands an alert, well-informed inspection force under the constant attention of the Engineer or one individual authorized by the Engineer to take any necessary immediate corrective actions required during the performance of the work.

Should the Engineer elect to delegate this authority, the authority should include the specific authority to stop the work immediately when any non-conformity or detrimental condition is found to exist and such condition is not immediately corrected by the Contractor upon request. The Contractor must be informed by the Engineer of the delegation of authority and to whom it is delegated.

The Contractor is required to submit a **Process Control Plan** for approval before placing concrete pavement. This Process Control plan is typically submitted 3-6 months before the paving operations are scheduled to begin. The process control plan should identify the operations and measures the Contractor is planning to take to ensure they are delivering a quality product. A detailed process control plan would identify specific individuals who are responsible for performing the quality control operations necessary to complete the work satisfactorily, types and frequency of testing, etc. to achieve an acceptable product without mimicking the Standard Specifications. Article 1000-3(F) requires the Contractor to submit a process control plan associated with the concrete plant operations. The Pavement Construction Section as well as Materials and Tests Unit should be involved in the approval of the process control plan.

It should be further noted that the Construction Unit provides advisory service to the Engineer on all concrete paving work. This service is available on both a spot check and on a call basis. The Engineer should fully utilize this service beginning with the Preconstruction Conference.

700-2 CONCRETE PRODUCTION EQUIPMENT

(A) CONCRETE PLANT INSPECTION - GENERAL

The Technician at the batching plant or central mixing plant is responsible for ensuring that all concrete materials comply with the Specifications, for their proper handling, and for ensuring that the materials are weighed into batches of the proper size. He also is responsible for performing tests on cement (for air content) and making the test beams used for determining the compressive strength of the concrete. Section 1000-3(F) indicates the Contractor's areas of responsibility for process control. The Technician should ensure that a copy of the Contractor's **approved** process control plan is posted in the field laboratory and should be familiar with that plan. The Plant (Batch) and Roadway Technician as appropriate should accomplish minimum sampling and testing indicated by the minimum sampling guide.

The Standard Specifications permit the use of batch plants, central mix plants, and batch plants with truck mixers in the production of concrete for concrete pavement. The requirements for batch plants, central mix plants, truck mixers and other specification requirements relating to concrete production are included in Division 10 of the Standard Specifications. In addition, the Materials and Tests Unit must certify the Contractor's plant.

Although aggregates are inspected and approved at the point of manufacture or source, the Plant Technician must ensure that the materials, as used, continue to meet the Specifications and have not become segregated or contaminated. The goal of the Technician at the plant should be to assure the production of concrete using the approved mix and ensuring and documenting that the Contractor obtains the desired workability, slump, and strength.

The Plant (Batch) Technician will also be required to keep records pertaining to materials received, daily operations, and test results of materials tested.

M&T Form 253P is to be completed by the Plant (Batch) Technician. The **M&T Form 253L** is to be completed by the Laboratory Technician. Both the Plant (Batch) and Laboratory Technicians are to submit daily their M&T 253 forms to the Roadway Technician. The Roadway Technician is to complete the **M&T Form 253R**. The M&T Form 253 reports are to be completed and submitted daily to the State Materials Engineer, even though some of the information to be shown is a repetition of that previously shown and even when no pavement is placed, as when the paving operation is rained out. Procedures regarding this form can be found in the Construction and Inspection of Portland Cement Concrete Pavement Manual.

A field laboratory meeting the requirements of Section 725 of the Specifications is to be furnished by the Contractor at the plant site. This laboratory should be located as close to the plant and stockpiles as is reasonable. The chamber for the water-lime storage tanks or the curing shelter for test beams furnished by the Contractor should be next to and readily accessible to the laboratory.

The Plant Technician will make 6 inch x 12 inch compressive test specimens in accordance with Article 700-15. The cylinders are to be made, cured, and tested in accordance with the procedures outlined in the Construction and Inspection of Portland Cement Concrete Pavement Manual.

The **Standard Specifications** requires the Contractor to run moisture tests on the aggregates each morning before paving operations begin, and as often thereafter as necessary to control the consistency of the concrete, with a minimum of 2 per day. The fine aggregate weights and course aggregate weights must be adjusted by the Contractor to account for the free moisture in the aggregate. A description of how to run these moisture tests is given in the

Portland Cement Concrete Certification Study Guide. The Technician should periodically observe the Contractor's testing procedures and document these observations in his daily report.

All concrete pavements are air-entrained; i.e., a certain amount of air in the form of minute, non-connected air bubbles will be intentionally included in the concrete mix. This is done by the use of an air-entraining agent. The mix design will be based on the inclusion of 5.0% air in the mix to which a tolerance of ± l.5% is allowed by the Specifications. The Plant Technician must test each car or each fourth truck tanker of cement received prior to use to ensure that cement already containing an air-entraining agent is not used. This test procedure is described in the Portland Cement Concrete Certification Study Guide. The Roadway Technician will keep the Plant Technician informed of the air content of the concrete based upon air testing that he performs at the roadway and the Plant Technician will advise the Contractor's plant superintendent so that appropriate adjustments may be made. The air-entraining agent may be measured automatically by dispenser, or may be measured by hand, and the agent should be added to the water as it is introduced into the mix or to the sand rather than to the stone. If measured automatically, the dispenser should be checked at least once each morning and once each afternoon to ensure the proper amount of agent is being dispensed.

Sampling of cement should be in accordance with the minimum sampling guide.

It is preferable that batch bins be loaded from stockpiles rather than from cars; however, if the Engineer authorizes the Contractor to load bins from cars, it shall be done continuously and not alternated with loading from stockpiles. This is necessary in order that proper correction of batch weights for moisture in the aggregate may be made.

A checklist of some of the items to be observed or checked relative to aggregate stockpiles is listed as follows:

1. The area that the stockpile is expected to cover should be cleaned of vegetation, and a minimum 75-millimeter (3-inch) layer of aggregate should be maintained over the entire area. The pile should be built in such a manner as to minimize segregation and shall be well drained.
2. When stockpiles are built by crane or conveyer belt, the material should not be allowed to drop free for more than 3 meters (10 feet) as larger pieces may fracture or the wind may blow away finer particles, altering the gradation. To prevent this, the clam bucket should be opened only a slight distance above the top of the pile, or if a conveyer is used, a chimney should be suspended below the end of the conveyer.
3. The lips on the clam bucket should fit tight enough to avoid spillage when placing aggregates in the stockpile or transferring them to the aggregate bins.
4. Boards, burlap, etc., used for patching holes in aggregate cars will frequently be picked up with the aggregates during unloading. These should be removed. Screens or "grizzlies" with maximum 150-millimeters (6-inch) square openings may be placed on top of aggregate bins and also on the skip of the paver to catch foreign material not previously removed. The screens should be cleaned several times daily or as needed.
5. When stockpiles are depleted, the loader operator should be warned to leave a thin layer of aggregate and not to include any foreign material when cleaning up the pile.
6. Operation of any vehicles on the piles should be avoided whenever possible. Tracked vehicles particularly may break up the large size aggregates. Rubber-tired vehicles should not be permitted to spin wheels on piles, as this will break up the aggregate with resulting changes in gradation. Care should be exercised so no earth material is carried on the stockpiles by tires or tracks.
7. Whenever trucks travel on a stockpile, boards must be used. The boards, preferably oak, must be a minimum of 2 inches in thickness, at least 12 inches wider than the wheels and

cleated to each other (salvaged bridge floor metal traffic treads have been used satisfactorily instead of boards).

8. Space should be left between stockpiles so that there will be no contamination of one size aggregate by another. In limited areas, adequate bulkheads should be placed between the piles.
9. It is important that fine and coarse aggregate be well graded and that the grading remain uniform throughout the life of the project. Visual examination should be made of the aggregate and stockpiles several times daily. The use of alternate wet and dry materials direct from the quarry should not be permitted.

(B) SPECIFIC REQUIREMENTS FOR BATCH PLANT INSPECTION

In the operation of batch plants, it is essential that materials be accurately weighed into the batches. All batch weighing equipment should be supported on concrete footings. Before starting a job, the scales shall be calibrated and checked for accuracy by a registered or licensed scale mechanic in the presence of the Plant Technician. The Materials and Tests Unit can provide guidance in the proper performance of the scale check. A stamp of inspection and approval shall be placed on the scales once approved. This should be done only after the bins have been fully loaded for a period of 24 hours prior to checking. For calibration, the Contractor shall furnish ten standard 22.68-kilogram (50-pound) weights and sufficient personnel to assist in making the scale test. A record of all calibration readings shall be kept on Form C2-1. After the initial calibration, the scales are to be recalibrated after three to five days of operation and once a week thereafter. At intervals of about one hour during batching, the scales should be checked by the Technician to see that they balance at zero.

If the scales fail to balance at zero, this indicates the batches are not being weighed accurately. This may mean that some material has remained in the hopper and is not being discharged. Particular care should be taken to observe the cement scale because there is a tendency for cement to cake in the corners of the hopper. The hopper should be adequately vibrated. After vibration, if cement scales fail to balance on zero, the scales must be reset with the main counterweight used for balancing the scales. It is very important that the correct amount of cement is weighed out for each batch. If beam scales are used, the set screws holding the counterweights in position on the beam arms must be tightened firmly with pliers. Vibration tends to move these weights and cause incorrect batching of materials.

Other items to be monitored and maintained:

1. Scales must be kept level at all times.
2. All fulcrums, clevises, knife edges, and all working parts must be clean and free from cement, dust, and dirt.
3. Never oil any working parts (this tends to collect dirt).
4. The bin framework should be equipped with a canvas trunk that will prevent blowing and consequent loss of cement during its transfer from hopper to truck. These trunks should be of sufficient length to extend into the cement box to prevent any loss of cement.

(C) SPECIFIC REQUIREMENTS FOR CENTRAL MIX PLANT INSPECTION

Mixers used for central mixing should be checked before construction begins. Principal points to be observed include the following:

1. The mixing blades should not be worn down more than 10 percent. If they are, the Technician should require that they be built up or replaced.
2. The water system should be tested at various settings of the water gauge and adjusted to ensure proper readings.
3. The mixer should be timed and the locking device in good working order to control the mixing time.
4. Valves should be checked for leakage.
5. The mixer should be checked frequently for build-up of set concrete on or around blades.
6. The air-entraining agent dispenser should be checked for proper operation. The dispenser and all piping should be maintained in a clean condition, and the air vent open to ensure discharge of the desired amount of agent.
7. The size of the batch, speed of rotation, and mixing cycle shall comply with the Specifications.

700-3 CONCRETE HAULING EQUIPMENT

When central mixed concrete is used, the Plant Technician should check each truck for compliance with the Specifications. All batch trucks should be inspected by the Plant Technician before being permitted to be used on the project. The batch dividers should fit tightly, and the compartments should be large enough to prevent any spillage during discharge.

The Plant Technician and the Roadway Technician must both keep check on time and length of haul. The time of haul, whether in agitating or non-agitating truck bodies, should not exceed the limits indicated in Article 700-3 of the Specifications. The elapsed time is defined as the period from first contact between mixing water and cement until the entire operation of placing and **finishing up to micro-surfacing** (burlap drag, or Astroturf drag), including corrective measures if necessary, has been completed. Under no circumstances, should the haul be long enough to cause loss of workability before finishing.

If the anticipated haul time exceeds the elapsed time defined in this Article, an extension may be allowed by the Engineer provided the concrete maintains mixture uniformity. Test procedure ASTM C94 Annex is used for determining mixture uniformity. The Materials and Tests Unit can be called to offer assistance when checking for mixture uniformity. Provided the concrete passes any five (5) of the six (6) concrete tests listed in the Annex, the elapsed time may be extended up to 1.5 hours.

700-4 PREPARATION OF SUBGRADE AND BASE

Divisions 5 and 6 of this Manual and of the Standard Specifications provide adequate guidance for the preparation of the subgrade and base. The Specifications require that the subgrade and base for concrete pavement be prepared using an automatically-controlled, fine-grading and paving equipment to produce the final subgrade elevations and asphalt base surfaces. This requirement may be waived by the Engineer in locations or areas where its use is not practical, with the concurrence of the State Construction Engineer.

The base course should provide a uniform support for the concrete pavement. Typically, a surface mix is placed on the subgrade to protect the subgrade for exposure to moisture. A drainage course is placed on top of the surface mix to act as a drainage layer. It is important to obtain as much density as possible in the surface mix to close as many air voids as possible; however, the drainage course should be left with as many air voids as possible while providing a stable platform for paving. The density requirements for the drainage layer should be relaxed.

Dampening of the surface of the base material is important to prevent the water in the concrete from being absorbed into the underlying base material.

Ideally the same stringline would be used for fine grading operations, placing the asphalt base courses, and pouring the concrete pavement. Care should be taken to ensure the string line does not have any sags and is tight. The spacing of the pins used to support the stringline should be spaced no farther than 50 feet apart in tangent sections. This spacing should be reduced to no farther than 25 feet in vertical or horizontal curves.

700-5 PLACING CONCRETE

Because proper construction practices are critical to the concrete pavement's service life, the Roadway Technician and the Laboratory Technician should ensure that placement of concrete shall not begin or shall be suspended when the following conditions occur:

1. When the descending air temperature in the shade away from artificial heat reaches 35°F, paving shall be suspended until an ascending temperature in the shade away from heat reaches 35°F.
2. When the subgrade or base course is frozen.
3. When the aggregates to be used in the mix contain frozen particles.
4. When air temperature in shade is 90°F and rising or the concrete temperature is greater than 95°F.

When additional pavement, aggregate or soil must be placed adjacent to new pavement by machine methods, do not place it until the concrete has attained a compressive strength of at least 3500 psi. This means that the paver or any other equipment weighing over 1000lbs. should not ride on the pavement until the estimated compressive strength reaches 3500 psi

A Roadway Technician must be present at all times when concrete is being placed. The Technician shall check and approve all aspects of the concrete paving operation - equipment, forms, string lines, etc. - prior to permitting the concrete paving operation to proceed. Particular attention should be placed upon the proper operation of the paver control systems and the possibility of stringline sag. The Contractor shall not be permitted to use control components that do not properly operate or conform to the manufacturer's suggested methods of operation. Assistance in checking the Contractor's equipment may be obtained by contacting the Pavement Construction Section of the Construction Unit.

It should be noted that the use of fixed continuous reference lines is required for both horizontal and vertical control. The Specifications allow modification of this requirement. The State Roadway Construction Engineer should be consulted prior to granting the Contractor's request to utilize mobile reference lines for vertical control.

The base material, except in the case of Cement Treated Base Course, should be thoroughly dampened ahead of the placement of the concrete by the Contractor. The moistened base shall be maintained in this condition until such time as the concrete is placed thereon.

When paving in the heat of the summer, white pigmented curing compound may be applied to the asphalt base to reflect some of the sun's radiant heat.

All dowel bar assemblies, dowel bars, and tie bars required by the plans should be thoroughly checked for conformity well ahead of the concrete placing operations. If the Contractor wishes to use a DBI (Dowel Bar Inserter) written approval will be necessary from the Pavement Construction Engineer.

Slump tests shall be performed in accordance with the procedure and at the rates given in the Portland Cement Concrete Certification Study Guide.

The testing for entrained air shall be performed on each compressive strength lot using a pressure type air meter. The results of such tests should be sent back to the batching plant in order that the Plant (Batch) Technician may know whether the amount of air-entraining agent being added to the mix is correct. Quick checks for information only may be made with the AE55; however, such testing is not intended to replace the test required to be run by the pressure method.

The provisions of this article relative to temperature limitations shall be rigidly enforced. In addition, paving shall be delayed or discontinued at any time when deflection of forms due to wet subgrade or base material indicates that the pavement will be deficient in thickness, or provide an unsatisfactory riding surface.

The concrete must be uniformly spread across the typical section. Concrete with uniform consistency will be easily workable without segregation. If excessive segregation or difficult concrete workability is observed, or if there is evidence of free water on the surface before or after spreading the concrete, an immediate investigation and determination of the cause of such conditions should be made.

The concrete must be uniformly spread across the typical section. The spreading of the concrete should be performed with a mechanical spreader independent of the paver. The spreader should provide a consistent head of concrete in front of the paver to allow the paver to maintain a constant speed. Some pavers are described as a paver/spreader but the spreader should be independent of the paver. All other things being equal, a heavier paver generally produces a smoother pavement because it is less affected by surges of concrete coming into the paver.

700-6 VIBRATING CONCRETE

Concrete vibrators, whether the pan or internal type, should be checked for vibration frequency before use. A representative from the Pavement Construction Section is available to perform frequency testing of vibrators. The pan type of vibrator is designed to apply vibration to the surface of the concrete uniformly for the full width of the pavement. The internal type must be equipped with vibratory units, so spaced that the effective area of vibration of each unit will slightly overlap that of the next unit. There must be sufficient units to vibrate the entire width of pavement.

The internal vibrating elements should be set to vibrate at 1/2 the slab depth. Pan or internal type vibrators should be raised from the concrete or cutoff when the unit is not moving forward to avoid over vibration.

The Contractor should furnish and operate an electronic vibratory monitoring device, displaying information such as operating frequency of each individual vibrator. A report which details the number of impulses from each vibrator should be reviewed by the Technician to verify that all vibrators are operating within the specified allowances.

The Technician should immediately inform the contractor if he notices any vibrator not operating within the allowable frequencies and inspect the slab behind the paver for any streaks of segregation.

700-7 FINISHING

Refer to Articles 710-6 and 720-7 for details on finishing concrete pavement or concrete shoulders, respectively.

700-8 PROTECTION OF PORTLAND CEMENT CONCRETE PAVEMENT

(A) GENERAL

The Specifications place the burden of protection of the concrete from environmental conditions upon the Contractor. However, it is often very difficult to make a determination of precisely how much damage has occurred and whether or not repairs can be made, or if the damaged pavement must be removed and replaced. The Pavement Construction Section is available to assist the Engineer in determining the extent of any damage and the appropriate remedial action that may be required.

Materials to protect the concrete pavement during the curing period should be readily available at the paving train.

(B) COLD WEATHER

In cold weather it is important to protect the concrete from freezing and to maintain curing conditions to ensure adequate strength development. If concrete freezes during the initial curing period, it may not continue to gain strength in a manner consistent with normal concrete performance. Some instances have shown that the maximum strength was 1/2 of what was anticipated.

When fresh pavement is exposed to possible freezing conditions, the Technician should record the high and low temperature for each 24-hour period on the surface of the slab beneath the protective covering each day. The surface and internal temperature of the pavement slab should be monitored further by using maturity meters. Because the corners are most heavily exposed to the environmental conditions, this is a good location to monitor the temperature of the slab.

The concrete slab must be protected from freezing during the entire initial curing period of the concrete pavement. The recording of temperatures should also be continued throughout this duration. The air temperature in the shade and away from artificial heat should be recorded during the same period and at the same frequency. This information should be included in the project diary.

(C) HOT WEATHER

Hot weather conditions, high concrete temperature, wind and low relative humidity, or combinations thereof can cause rapid evaporation of the concrete pavement, which significantly increases the likelihood, that plastic shrinkage cracking or drying shrinkage cracking will occur.

The high rate of evaporation can dry and remove surface water beneficial for proper hydration **unless proper moist curing methods are employed**. High temperatures accelerate slump loss, and can cause some loss of entrained-air, and increase water demand resulting in lower compressive strength. Temperature also greatly affects the setting time of concrete.

When paving in hot weather all facets of the paving operations should be watched closely. Concrete should be placed in a timely manner. Curing should be applied as soon as possible to hold in the water needed for hydration of the concrete and to prevent plastic shrinkage cracking.

(D) RAIN

A check of the availability of protective covering at the job site for protection from rain should be made and recorded in the project diary. The use of polyethylene film for this purpose is practically universal but serious surface slicking can result from its use. Efforts by the Contractor to protect the pavement during a rainstorm and restore the surface finish after a rainstorm should be encouraged, if appropriate, and fully recorded in the project diary. The Contractor will be responsible for providing a pavement and pavement surface that meets the Specifications.

700-9 CURING

(A) GENERAL

Curing is one of the most important phases of concrete paving. Proper curing will minimize shrinkage cracking and future surface wear. **The curing process must be started as soon as possible after the surface water film has disappeared but while the surface is still in a moist condition.** All curing material must be uniformly applied to the **top and sides** of the slab at the specified rate or thickness.

A curing day is any consecutive 24-hour period beginning with the mixing of the concrete when the air temperature next to the slab does not fall below 4°C (40°F). During cool periods, a hi-low thermometer should be used to keep a daily check on the temperature beneath the protective covering. These readings shall be recorded in the project diary. Refer to Section 1026 of the Standard Specifications for more details on curing agents for concrete.

(B) MEMBRANE CURING COMPOUND

Membrane curing compound is accepted by lot number after it has been tested and approved for use by the Materials & Tests Unit. It may be used from the date of manufacture until its expiration date, one year later. The expiration date shall be listed on the container. Membrane curing compound will not be retested and may not be used after the expiration date.

Membrane curing compound should be agitated in the container before and during application. It should not be used until thoroughly mixed. This can be accomplished by use of compressed air or mechanical agitators. The machine used to apply the curing compound should be equipped with an agitator, pump and inline flow metering device. The Technician should

check to see that spray nozzles are clean and deliver a uniform coverage over the full width of the slab. For pavement constructed using forms, curing shall be applied to the sides of the slab immediately after the removal of the form. The rate of application should be checked for compliance with Specifications. Only white pigmented membrane compound may be used for curing concrete pavement. The membrane curing compound film shall be protected from damage at all times and if damaged, repaired as soon as possible.

The newly placed concrete should not be exposed for long periods before curing compound is applied. As a general guideline, it should be covered within 30 minutes; however, this time frame may vary with the temperature and/or the season. In warmer temperatures this time period may need to be reduced, and in colder temperatures this time period may be extended. Regardless of the season, the pavement surface should covered as soon as possible after the sheen has disappeared from the slab.

(C) POLYETHYLENE FILM

The Specifications are specific in the requirements for the use of several other methods for curing concrete pavement. If other methods are used, the Roadway Technician should see that the Contractor strictly adheres to all requirements.

(D) BURLAP

While the use of burlap material is not very common due to its cost and labor intensity, Contractors may elect to use fully saturated burlap sheets to cure the smaller pours. The burlap material must remain saturated throughout the curing period.

700-10 REMOVING FORMS

The concrete shall be at least 12 hours old before removing forms. All honeycombed areas must be repaired immediately after the forms are removed. Curing compound should be applied to the newly exposed surfaces.

700-11 JOINT CONSTRUCTION

(A) GENERAL

After placing and finishing concrete pavement, saw cuts are created to control the location of cracking and to provide relief for concrete expansion caused by temperature and moisture changes. Contraction joints, both transverse and longitudinal, are designed to give a deliberate plane of weakness in the slab such that cracks caused by shrinking of the concrete during hardening and temperature variations will form in a neat line, thus eliminating irregular, unsightly, spall-susceptible cracking. The joint must also be formed such that it can be sealed with a flexible adhesive material to waterproof the subsequent cracks.

Transverse joints are cut in the concrete slabs directly over dowel bars such that once the concrete does crack the dowel bar will assist with the transfer of live loads from one concrete panel to the next without displacement or faulting of the joint. Longitudinal joints are cut directly over tie bars such that the two lanes will still be physically attached even in the presence of a full depth controlled crack.

Both transverse and longitudinal joints should be formed using an early entry dry cutting saw system. Any change from the procedure set forth in the plans, standard drawings, and Specifications must be approved by the State Construction Engineer.

Joint construction is an area where proper techniques and thorough inspection by project personnel can contribute immensely in reducing future maintenance costs. The cost of maintenance of joints in concrete pavement can be almost directly related to the workmanship which went into the original construction of the joints. This maintenance involves repairing of spalled concrete, faulted joints, and non-adhesion of joint sealer. Not only does poor joint construction increase maintenance costs, but it also results in poor rideability and subsequent public criticism. Accordingly, the Technician should be thoroughly familiar with the Specifications, plans and standard drawing requirements, and the guidelines set forth in this Manual. Refer to the most recent version of the **Roadway Standard Drawings** or contract special provisions for specific details on joint construction, details, dimensions, layout (spacing), dowel assembly details, header details, etc. See Drawing Nos. 700.01 through 710.01.

All joints shall be constructed in accordance with the joint detail required by the plans and/or standard drawings. The joints shall be sawed or formed with the joints spaced as required by the plan details. The initial saw cut to provide stress relief shall be at such interval and frequency to control random cracking.

Defining the initial sawing window in the field can be done by the *scratch test method.* Experienced saw operators and technicians rely on judgement and the scratch test to estimate the appropriate time to saw the joints. The test involves scratching the concrete surface with a nail or knife blade, and then examining the depth, uniformity, and influence on the surface. In general, if the scratch removes the surface texture, it is too early to saw without raveling problems.

The time for sawing joints will vary, depending upon weather, atmospheric conditions, and the aggregate. When the weather is hot or windy, it is be expected that the available sawing window will be narrowed and therefore, sawing will need to be performed earlier. However, on colder more humid paving days, the window for sawing may be expanded. In most cases, joints need to be sawed within seven hours after placement of concrete with an **early entry dry-cutting sawing system**. Frequent checks should be made by measurement of joint widths and depths

When the Contractor is cutting transverse and longitudinal joints, a Roadway Technician should be present to document the time after placement of the slab when the sawing operation began and was completed as well as the depths of the initial and final saw cuts. These depths and times should be recorded in a pay record book and noted in the Technician's Daily Report.

To minimize joint spalling, it is essential that no non-compressible materials such as grout, sand, gravel, pieces of concrete, dirt, etc., be allowed within the initial or final cuts of the Transverse and Longitudinal joints during construction operations. When the Contractor is cutting the initial cuts, Transverse or Longitudinal, the residue from the sawing operation should be cleaned out and away from the 1/8" initial cut and kept clean during the construction phase of the project until the "reservoir cut" is made, cleaned, and sealed.

In addition, when placing concrete adjacent to a previously poured pavement, the void from the saw cut and any crack opening should be taped or protected to prevent grout from the newly poured slab from intruding into the opening. Care must be given for the top surface of the slab as the grout is often displaced during finishing operations and this grout can fall into the sawn opening.

(B) TRANSVERSE CONTRACTION JOINTS

The project personnel should check the dowel basket assemblies at the site. The baskets should be visually checked by the Roadway Technician for compliance with the contract requirements and to verify that the dowel assembly has not been damaged, misaligned, or otherwise installed in an unsatisfactory manner. The dowel assemblies are normally inspected at the fabricator's site by the Materials & Tests Unit or their agent and tagged accordingly. If the dowel assemblies do not appear to be within compliance with the contract requirements, call the M&T Section Specialist for your area.

The locations of the dowels must be accurately referenced transversely such that the sawed joint can be placed exactly over the centerline of the dowel assemblies. "Locked joints" can develop if the dowels are not placed parallel to the profile grade line, if the assemblies are not adequately fastened down, if burrs are not removed from the dowels, or if the dowels are not properly coated. It is important to ensure that the dowel baskets are secured properly to the surface. The baskets may be displaced or shifted by the concrete surge caused by the spreading and/or finishing machine.

When staking pins are used to secure the basket assembly, the pins should be on the opposite side of the approaching paver. Staking the basket down this way will reduce the likelihood of the basket becoming dislodged when the spreader and paver pass through.

After the dowel baskets are set and secured, the spreader wires used to hold the dowel assembly together should be cut to allow unrestricted movement at the joint and allow further testing for appropriate location.

Frequent visual observation should be made by the Roadway Technician during the spreading of the Portland Cement Concrete to verify the head of material in front of the spreader and/or paver is not displacing the dowel baskets and tie bars. The location of the joints with respect to dowels and tie bars should be checked frequently by probing or by using a metal detector to insure that they are in correct position.

A MIT Scan is able to verify the alignment of the dowels should there be any question about the basket assembly or dowel alignment. Contact either the Materials and Tests Unit or the Pavement Construction Section for assistance with the MIT Scan.

(C) LONGITUDINAL CONTRACTION JOINTS

A longitudinal joint is necessary whenever the width of pavement poured is greater than 16 feet. Care should be taken not to place a longitudinal joint in the final wheel path. All longitudinal contraction joints shall be sawed directly over tie bars. The sawed joint must be sawed within seven hours of concrete placement with an **early entry dry-cutting sawing system**.

All tie bars for longitudinal contraction joints are deformed and must be placed at right angle to the joint. The horizontal and vertical placement of these bars should be periodically checked for conformity with the plans.

Where longitudinal contraction joints are required, the joints should be placed at the location of the permanent proposed traffic lanes.

(D) TRANSVERSE CONSTRUCTION JOINTS

"Planned Transverse Construction Joints" are those joints necessitated by the suspension of work at the end of a workday. These joints are to be made at the same location as required for a transverse contraction joint.

There are two common construction methods for planned transverse construction joints. Some contractors elect to use a header board. If a header board is used, it must be perpendicular to the profile grade line and must support dowel bars parallel to the profile grade line. Adequate hand vibration is required in the areas adjacent to the header board. Other Contractors elect to saw the slab full depth and drill and epoxy dowel bars into the sawn face of the slab. This method of planned construction joint often yields smoother transverse joints.

"Emergency Transverse Construction Joints" are those transverse joints required when concrete placement has been suspended for more than 30 minutes for any reason. This joint shall not be formed or sawed but shall be a butt joint. An emergency transverse joint shall not be within six feet of a planned transverse contraction joint and shall not affect the spacing of transverse contraction joints.

Emergency Transverse joints require the placement of deformed tie bars that are equal to the diameter of dowel bars. The reason for the deformed tie bars is to purposely create a locked joint.

If the Contractor elects to use a header board to construct an emergency joint, the board must be perpendicular to the profile grade line and shall support deformed tie bars parallel to the profile grade line. Adequate hand vibration is required.

The operation of starting or stopping concrete pavement construction is always a critical one and the quality of work performed at the headers will often determine the final ride quality of the pavement. The Roadway Technician should always be present and observing that the proper amount of vibration and finishing work is performed and that dowels or tie bars, where required, are properly aligned and spaced. Care should be exercised to prevent “dead concrete” or mortar, which has built-up on equipment during the day's operation, from being placed in the fresh concrete near the header. The Technician should use good judgment in this matter but may direct the removal of concrete so contaminated when the contamination will apparently be detrimental to the finished pavement. This inspection task is very important in helping to prevent future maintenance problems and costs.

(E) LONGITUDINAL CONSTRUCTION JOINTS

Longitudinal Construction Joints constructed in accordance with the referenced standards are permitted for pavement widths in excess of 16 feet, such as for additional traffic lanes and acceleration/deceleration ramp tie-ins.

Normally, tie bars are required for longitudinal joints for both slip form and fixed form paving and are placed into the plastic concrete by hand. With the slip form method, it is suggested that a form board predrilled with the correct size holes and spacing be placed flush with the sides of the pavement and the bars then pushed into the concrete. This eliminates edge slump and surface distortion problems. Edge slump should be monitored constantly to ensure that the 1/4-inch maximum is not exceeded.

In either event, where longitudinal construction joints are required, the joints should be placed at the location of the permanent proposed traffic lanes.

(F) TRANSVERSE EXPANSION JOINTS

Transverse Expansion Joints in concrete pavement are normally placed at or near bridge approaches. The baskets for expansion joints should be checked prior to beginning the areas around the expansion joints for compliance. The Bridge Technician should make a sketch of which dowel bars have expansion caps on them at the approach slab so that the PCCP Roadway Technician can place his expansion caps on the correct dowels (See 700.03 Sheet 2 or 2 of the Standard Drawing "Partial Plan Expansion" Section).

Expansion joints are placed to help prevent cracking due to thermal expansion in concrete. They provide a complete separation between two parts of a slab. The separation is sealed with silicone sealant to allow movement of the slabs and to prevent buckling. Accordingly, it is absolutely necessary that no non-compressible materials such as stone, gravel, pieces of concrete, dirt, etc., be allowed within the expansion joints during construction. The design also provides for load transfer from one slab to another by means of dowel bars. The same care must be exercised here as discussed in Item (B) above.

VERIFICATION OF DOWEL BAR ALIGNMENT

In Article 700-11(G) "Verification of Dowel Bar Alignment" the specifications require the use either properly secured dowel baskets or a dowel bar inserter, provided the ability to correctly locate and align the dowels at the joints is demonstrated.

The contractor is to provide a calibrated magnetic imaging device that will document the dowel bar location and alignment. The contractor will utilize this device as a part of his process control and make any necessary adjustments to ensure the dowels are placed in the correct location.

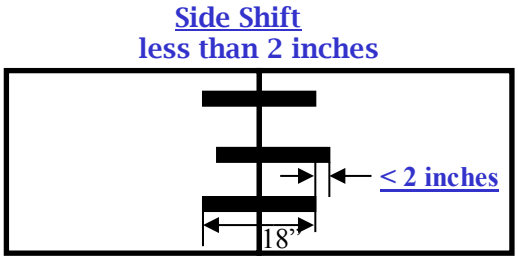
The contractor will scan at least 25% percent of the joints in the initial placement or 1.0 mile of pavement, whichever is greater, at random intervals throughout the pavement each time the paving train is mobilized.

He will scan all joints in this initial section if the dowel bars exhibit side shift, horizontal displacement, vertical displacement, horizontal misalignment, or vertical misalignment, above the allowable tolerances defined below. In addition, he will continue scanning 25% of the joints until it is established that the dowel bar inserter or secured dowel basket assemblies are consistently being placed at the correct location (meeting the tolerances defined below). Once the engineer determines that consistency is established, the contractor may reduce the percentage of scanned joints to 10%. At any time, inconsistency in the placement of the dowel bars become evident, additional scanning may be required up to 100% of the joints.

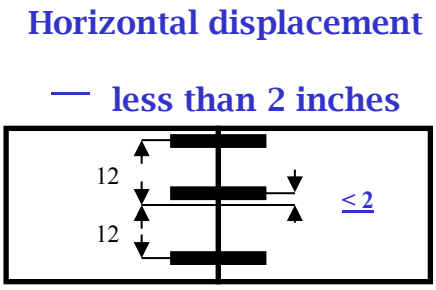
If the consistency of the proper dowel bar alignment cannot be established within a reasonable time frame, the Engineer will have the option of suspending the paving operation.

The contractor will provide a report of the scanned joints. This report should include the station and lane of the joint scanned, as well as the horizontal location, depth, horizontal and vertical misalignment, and lateral displacement or side shift of each dowel bar in the joint. The joint score described below should also be provided in the report.

Side shift is defined as the position of the center of the dowel bar in relation to the sawed joint. The maximum allowable side shift is 2 inches

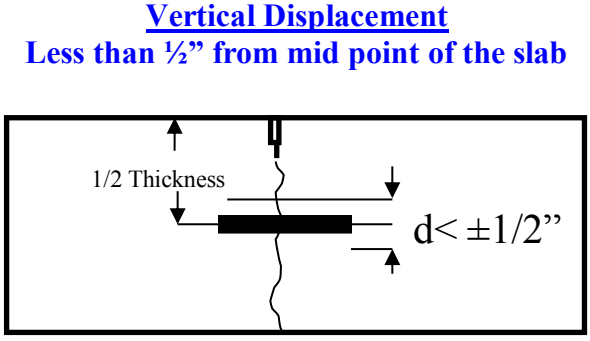


Horizontal displacement is defined as difference in the actual dowel bar location from its theoretical position as detailed in the standard details. The maximum allowable horizontal displacement is 2 inches.



Plan

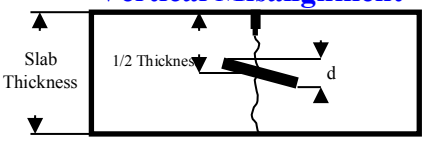
Vertical displacement (depth) is the difference in the actual dowel bar location from the theoretical midpoint of the slab. The maximum allowable vertical displacement depth is 1/2 inch.



Profile View

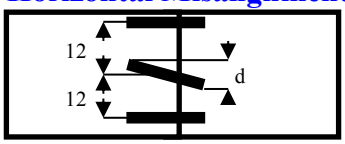
Dowel bar misalignment is defined as the difference in position of the dowel bar ends with respect to each other. Vertical misalignment is measured in the vertical axis whereas horizontal misalignment is measured in the horizontal axis.

Vertical Misalignment



Profile View

Horizontal Misalignment



Plan

Determining a joint score for each joint scanned as below:

Joint Score = ∑(# of bars * Misalignment Category)+1

Example: A joint has 12 bars. 10 are aligned correctly. 1 bar is misaligned 16mm, and 1 bar is misaligned 22mm.

Joint Score = ∑ **{(10*0) + (1 * 2) + (1 * 4)} + 1**

Joint Score = 7

The joint score is a measure of combined effects of horizontal and vertical misalignment. The joint score is determined by summing the product of the weight (shown in the table below) and the number of bars in each misalignment category and adding 1. The vertical and horizontal dowel misalignment should be evaluated and the greater misalignment shall be utilized in determining the joint score.

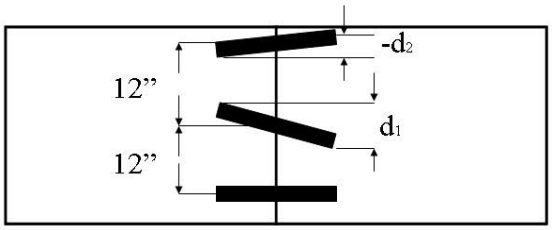
Misalignment Category, mm	**Weight**
0 <= d <= 15	0
15< d <= 20	2
20< d <= 25	4
25 < d <= 38	5
38 <= d	10

Where d is the individual dowel bar misalignment.

A joint that has a joint score of 10 or greater will be considered locked.

Identify any scanned joints where the opposing horizontal or vertical misalignment of any two bars within the joint exceeds 1 inch. This situation will be considered a locked joint.

Evaluate joints for opposing skew (Cross-Stitching)
- less than 25mm or 1-inch



Opposing Skew = d_1-(-d_2) < 25mm

When a locked joint as defined above is discovered, scan the two joints immediately adjacent to the locked joint. If either of the adjacent joints are deemed to be locked, provide a written proposal to address the dowel misalignment for each locked joint. No corrective action should be performed without written approval.

Any and all corrective action necessitated by improper joint alignment shall be at no cost to the Department.

700-12 SEALING JOINTS

(A) GENERAL

All joints shall be sealed with low modulus silicone sealant. Low modulus silicone sealant is accepted by brand name. The Materials & Tests Unit maintains a list of approved sources. A Type 3 Manufacturer’s Certification is required for each lot of joint sealer shipped to a project. The manufacturer’s recommendations and/or applicable standard drawings will detail the joint seal configuration. It is of utmost importance that the design dimensions and shapes are achieved in the construction of the joint. Proper joint function can only be achieved by proper joint shape and by good sealant-concrete adhesion. The Engineer should schedule a meeting with the Contractor, his personnel, and a representative from the Pavement Construction Section for review of joint construction prior to beginning this phase of work.

Construction traffic may operate over joints, which have been initially sawed only. No traffic of any type will be allowed on the pavement after the final sawing joints until the installation of the joint sealer has been completed and the sealer is tack free. The sawing and sealing of all joints must be complete before permanent traffic is placed on the pavement.

(B) AGE OF PAVEMENT

The concrete shall be at least 14 days old before the joints are sealed. It is also required that the surface testing, correction, and adjacent construction, including earth shoulders be complete prior to final sawing and sealing operations.

(C) TEMPERATURE

The minimum air temperature is very critical to good joint and sealant performance. Placing sealant when the temperature is less than 7°C (45°F) should not be allowed unless approved by the State Roadway Construction Engineer.

(D) SEALING THE JOINT

The joint shall not be filled until it has been resawed, cleaned, and dried. This shall be accomplished by sandblasting. Just prior to sealing, the joint is "blown out" with compressed air. It is extremely important that the compressor used to supply air for cleaning joints be equipped with traps, which will remove compressor oil and water from the air supply. Oil or water stains on the joint wall will prevent the proper bonding of low modulus silicone sealant to the joint wall. The Technician shall specifically check to ensure the compressor is equipped with the traps noted above.

(E) CLEANING PAVEMENT

Cleaning is best achieved by good workmanship during placement of the sealant. Refer to the sealant manufacturer's recommendations for curing requirements.

700-13 USE OF NEW PAVEMENT OR SHOULDER

The timely opening of Portland Cement Concrete pavement or PCCP to traffic is often extremely important. However if traffic, especially construction traffic, is allowed on the pavement before the concrete has gained sufficient strength, the service life of the concrete pavement may be adversely compromised. Therefore no traffic, including construction traffic, is allowed on the completed pavement slabs until the compressive strength of the concrete has reached 3500 psi.

To determine the compressive strength of the concrete, the maturity method will be used. To determine the compressive strength of the concrete using the maturity method, a strength-maturity relationship must be developed and verified. The procedures for developing the maturity curve, estimating the in place concrete's strength, and verifying the maturity curve are included in the Construction and Inspection of Portland Cement Concrete Pavement Manual.

Before traffic is allowed on the concrete slab, the Roadway Technician should verify and document that the maturity index is greater than the required Temperature-Time factor target. This documentation should be recorded in the Technician's Daily Report.

In the absence of a strength maturity curve, traffic should not be allowed on the concrete slab until test beams representative of the pavement have attained a compressive strength of 3500 psi.

For the placement of permanent traffic, the sawing and sealing of all joints must have been completed. Construction traffic may operate over joints which have been initially sawed only. No traffic of any type will be allowed on the pavement after the final sawing joints until the installation of the joint sealer has been completed and the sealer is tack free.

700-14 CONTRACTOR'S RESPONSIBILITY FOR PROCESS CONTROL

The Specifications require the Contractor to perform process control sampling and testing of concrete materials, the finished concrete mix, and the paving operations to ensure the pavement meets the requirements of the Specifications.

The Contractor should be advised at the Preconstruction Conference that the Roadway Foreman and all personnel who will be involved with the batching, sampling, and testing of the Portland Cement Concrete pavement need to be certified by the Department. The Contractor and/or the Engineer should contact the Materials & Tests Unit and/or the Pavement Construction Section to determine when certification training and the required examination(s) are scheduled for all that will be involved with the Portland Cement Concrete pavement.

The Specifications list 10 items that the Contractor must address in his submitted Process Control Plan (See 700-1 of this Manual for additional information to be included in the Process Control Plan.). The Process Control Plan should not be a copy of the Standard Specification but detail all the operations necessary in the production and placement of the concrete pavement, including the testing and frequency of the testing, etc. After the Contractor's Process Control plan has been approved, each Technician on the project should receive a copy and become knowledgeable of the plan. The results of all tests are to be documented by the Contractor. These documented results are to be made available to the Engineer. It is the responsibility of the Engineer to frequently check the Contractor's records, make "spot" checks or independent tests, and to document the results of these inspections of the Contractor's records or other tests.

The process control testing required by this section of the Specifications in no way relieves the Engineer of the responsibility for acceptance testing. The acceptance tests are outlined in the Minimum Sampling Guide and the Construction and Inspection of Portland Cement Concrete Pavement Manual.

700-15 ACCEPTANCE TESTS FOR CONCRETE

(A) RESPONSIBILITY

The Contractor is responsible for producing, furnishing, and providing quality control on the concrete. The Department is responsible for sampling, testing, and acceptance of the concrete for payment. The project personnel should consult the Minimum Sampling Guide and the Construction and Inspection of Portland Cement Concrete Pavement Manual for guidance in determining the minimum sampling and testing required for both process control and acceptance purposes.

(B) LOT DEFINITION

Refer to Articles 710-4 and 720-4 for the definition of lots for acceptance purpose on concrete pavement and concrete shoulders, respectively.

(C) AIR CONTENT

Refer to the Materials & Tests Minimum Sampling Guide and the Construction and Inspection of Portland Cement Concrete Pavement Manual for the frequency and procedures for performing air content tests.

The sample taken for determination of the air content should be obtained as soon as the concrete is discharged on the road. All concrete that does not meet the Specifications must be fully removed from the road and not incorporated into the final pavement structure.

(D) SLUMP

Refer to the Materials & Tests Minimum Sampling Guide and the Construction and Inspection of Portland Cement Concrete Pavement Manual for the frequency and procedures for performing slump tests on concrete.

(E) COMPRESSIVE STRENGTH

Refer to the Materials & Tests Minimum Sampling Guide and the Construction and Inspection of Portland Cement Concrete Pavement Manual for frequency and procedures for preparing and testing the compressive strength of concrete pavement test beams.

The Contractor and/or the Engineer should contact the local Materials & Tests Unit's Section Specialist prior to beginning work to determine when field certification training and the required examination(s) can be scheduled for all Technicians involved with the PCCP Laboratory Technician Certification.

The Engineer and the project personnel should carefully review the method and procedure for establishing lots. This procedure is very important because it will determine the square yardage of concrete to be affected if an adjustment in pay is necessary. There are several different items to be concerned with, such as the width of the paving operation and the type of pavement; i.e., mainline, ramp, miscellaneous, etc. The Specifications list the criteria for each case and outline the procedures which are to be followed. The Pavement Construction Section of the Construction Unit should be consulted if there are any questions on the methods and procedures for establishing lots.

The Specifications give the procedures that are to be followed in determining the "pay factors" as they apply to compressive strength. In order to standardize the procedures, the following will apply:

1. The Engineer will determine the lot limits. This should be done to the extent possible prior to beginning paving operations.
2. Project personnel will sample the concrete and prepare 6 inches x 12 inches compressive strength test cylinders.
3. At the completion of 28 days, project and/or lab personnel will test the compressive strength cylinders and report the results to the Engineer.
4. The Engineer will report the test results to the Materials & Tests Unit and the Pavement Construction Section.
5. The Engineer shall calculate the pay factors for compressive strength to the nearest tenth of a whole percent and advise the Contractor of the result of these determinations.

Whenever the compressive strength cylinders indicate concrete that fails to meet the minimum compressive strength specified, the Engineer shall immediately notify the State Roadway Construction Engineer.

(F) THICKNESS

The thickness of both concrete pavement and concrete shoulders are determined for acceptance purposes by obtaining cores from the pavement or shoulder. It is important that the same lot determination used for compressive strength be used to determine the acceptable thickness of the pavement.

Payment will be made in accordance with Articles 710-9 or 720-9 for concrete pavement or concrete shoulders, respectively. Please refer to these Articles for specific details.

The Contractor should patch all core holes within 72 hours of taking the core using a Department approved non-shrink grout compatible with the pavement or shoulder concrete.

(G) SURFACE SMOOTHNESS

Article 710-7 describes in detail the surface smoothness requirements for concrete pavements. If the concrete pavement does not meet the required surface smoothness requirements, the Contractor shall correct the pavement surface to the required smoothness by the use of diamond grinding, removal and replacement or other methods approved by the Engineer.

The Contractor and/or the Engineer should contact the Pavement Construction Section prior to beginning work to determine when field certification training and the required examination(s) can be scheduled for Technicians involved with the PCCP Profilograph Technician Certification.

TECHNICIAN'S CHECKLIST
SECTION 700
CONCRETE PAVEMENTS AND SHOULDERS

General

1) Study Specifications, plans, and Special Provisions.
2) Review Contractor's Process Control Plan.
3) Before the start of paving operations obtain slump cones, air test meters, rulers, pencils, necessary forms, etc., which are required for the job, and make sure that all testing equipment is in good working condition.
4) Verify that the producer's personnel hold the necessary certifications.
   Batch Plant Operator (Batch Plant Certified, PCCP Certified)
   Producer's Laboratory Technician (PCCP Lab Certified)
   Producer's Roadway Foreman (PCCP Roadway Certified)
5) Record in diary all conversations, observations, spot checks made, and work performed.

Plant Operation Checklist

6) Become familiar with the producer's concrete batching and mixing equipment.
7) Verify that the Plant, Scales, etc. have been checked and approved by the Materials and Tests Unit.
8) Obtain samples of the cementious materials (cement, flyash, blast furnace slag, etc.) at the beginning of the project and each load from a railroad car or every fourth truck tanker thereafter, to determine the origin and to assure that cement does not already contain air-entraining agent.
9) When new materials arrive, compare the material sources to the approved Concrete Mix Design.
10) Observe the batch plant technician weigh at least one load from each lot. Verify that the batch weights are within the acceptable tolerances.
11) Check air-entraining dispenser at least once each morning and once each afternoon.
12) Check cold feed bins and piles and assure that there is no contamination or inter-mingling of the aggregates.
13) Verify that stockpiles are spaced or separated to prevent inter-mingling of the aggregates. Other items to check for in stockpiles are as follows:
    - The stockpiled area should be cleaned of vegetation, well drained, and covered with a layer of aggregate.
    - The material, when handled by clam bucket or conveyer belt, should not be allowed to drop free for any appreciable distance.
    - Avoid inclusion of foreign material when cleaning up stockpile.
    - Avoid use of tractor vehicles on large aggregate stockpiles.
    - Maintain space between stockpiles and in limited areas use bulkheads.
14) Verify that no concrete remains in the trucks after dumping and is washed clean for the next load of concrete.

15) Make periodic checks during the day of the entire plant to see that it is functioning properly. Principal points to be observed:
    - Mixing blades not worn down more than 10 percent
    - Water system tested
    - Mixing time
    - Valves checked for leakage
    - Mixer checked frequently for buildup of concrete around blades
    - Air-entraining dispenser checked, all piping clean and air vent open
    - Size of batch, speed of rotation, and mixing cycle in compliance with Specifications
    - Time from batching of concrete to placement shall not exceed the Specification requirements.
    - Specific requirements for batch plant and truck mixer inspection
16) Ensure that a signed Batch Ticket (M&T Form 903) or approved delivery ticket is being sent to the Roadway Technician on the roadway for each load being batched.
17) Check trucks periodically to see that beds are clean and that no excess concrete is stuck in the bed. If so, bed should be washed before loading of the next load of concrete.

Roadway Inspection Checklist

18) Check the producer's paving equipment and understand the function of each piece of equipment.
19) Check paving equipment for proper adjustment (lane width, depth, etc).
20) Become familiar with the paving sequence of the project and review field controls for line and grade.
21) Become familiar with the Producer's and/or Contractor's concrete paving equipment and understand the function of each piece of equipment. Check paving equipment for proper adjustment and compliance with the Standard Specifications. (If help is needed with this please contact the Pavement Construction Section.)
22) Verify that the Producer and/or Contractor has a Inertial profiler & competent Operator for the profiler.
23) When dowel bars and tie bars arrive on the project contact the M&T Section Specialist for field verification.
24) Check the dowel bars for size, length, welding, and spacing (if using dowel baskets). The dowel baskets should be accompanied by a M&T Form 913 (Epoxy Coating Certificate) and a Type 1 Certified Mill Test Report with Wax coating verified.
25) Check the placement of dowel bars in bridge approaches. Dowel bars should be parallel with the traffic flow and have approved expansion caps for the dowel bars.
26) Check the vibration equipment and, if furnished, verify vibration monitors are operating correctly. Computerized vibration monitors are required on slipform pavers per the 2006 Standard Specifications.
27) Verify that the Contractor is prepared for inclement weather (rain, hot or cold weather conditions) and has material on hand at the paving train.
28) Verify the stringline is set sufficiently in advance of the concrete paving to avoid delays.
29) Take appropriate tests as required by the Minimum Sampling Guide.
30) Verify that an automatically controlled grading and paving machine was used to establish the following items before paving begins:

- Asphalt pavements for conformity to line, grade, and typical sections, and record results. Advise Contractor of any areas needing correction.
- Be familiar with any grade adjustments made by Engineer.
- Discuss any necessity for grade adjustment with Engineer.
- If grade adjustments are made, advise other Technicians.
- Check line and grade at structures carefully for smooth transitions.
- Do not permit hauling equipment on the asphalt base course except as may be allowed by the Specifications.

31) When the Fixed Form Paving Method is being used, verify the following:
- Forms are clean and oiled.
- Forms are set sufficiently in advance of paving to allow inspection.
- Forms are uniformly supported and tamped.
- Locks are securely fastened.
- Pins are securely locked in stake pockets.
- Correct distance from centerline or offset hubs.
- Correct width between forms.
- Forms on each side at correct elevation.
- True to smooth line and grade - checked by eyeing in top of form.
- Removal prior to 12 hours after concrete placed not permitted.
- Damage to edge of slab and honeycomb repaired immediately and before curing compound is applied.
- Proper curing of edges when forms are removed.
- Proper grade to match bridge approach at least 160 feet from the approach.
- Marks should be made for transverse joint locations for correct sawing location on the dowel baskets. Confirm that joint locations are marked at the same location as the dowel baskets.
- Check that the base material is maintained in a dampened condition ahead of the concrete placement.

32) When paving with ready-mix trucks the Roadway Technician should check for items, which could cause problems with the placing of the PCC pavement. Some items to be checked are:
- Check drum revolutions per minute several times daily and record in diary.
- Water discharge calibrated and valves checked daily for leakage.
- Check inside mixer drum for worn blades or built up concrete.
- Check mixing time for compliance with Specifications and record in diary.
- Water should not be necessary when concrete is used for PCC pavements. Mixes should be well tested before using the mixes on the roadway.
- If mix is not of proportion by visual inspection, advise Plant Technician and check for reason.

33) When placing PCC pavement the roadway Technician should check for items, which could cause problems with the placing of the PCC pavement. Some items to be checked are:
- Check subgrade with a string line. Record results of stringline check on 50-foot intervals.
- Check the forms to see that they are thoroughly oiled.
- Ensure the base course is dampened when placing concrete. However, no free water or ponding should be present at placement.

- Verify the concrete is spreading easily without segregation giving even spreading and uniform strikeoff.
- Check the Dowels, tie bars, and joint assemblies to assure that all are according to plans and Specifications. If the steel is not correct, call the M&T Section Specialist.
- Verify the concrete placement operation did not dislocate the dowel bars or dowel bar assemblies (A metal detector could be helpful).
- Verify the speed of the paving train equipment is matching the slowest part of the paving operation. Stopping should be minimized to alleviate bumps.
- Check that the concrete pavement is maintained at a uniform consistency.
- Perform slump tests and air entrainment tests at the required frequency as per the Minimum Sampling Guide, Construction and Inspection of Portland Cement Concrete Pavement Manual, and the Engineer. Keep Plant Technician informed of any changes or problems that may arise.
- Assist the Plant Technician in making test beams, if possible.

34) When placing PCC pavement the roadway Technician should check spreading and vibrating items. Some spreading and vibrating items to be checked are:
- Check to see that the paver is not over or under loaded and that concrete is rolling and not sliding in front of the screed.
- Assure the use of minimum adequate vibration.
- The Contractor should check vibrators at the beginning of each day's operation. Ask the Contractor to verify vibrator operation in conformity to Standard Specifications.
- Check the mortar depth on surface with the index finger. If the mortar is more than 1/8 inch in depth, it may be due to over vibration.
- Check the concrete in front of screeds for the rolling affect ("Uniform head"). If this is not occurring, check the air and slump and notify the Plant Technician if air or slump is out.

35) When observing PCC pavement, the roadway Technician should check the following finishing items:
- Check top of slab with a stringline and rule using uniform sized blocks set on top of forms several times daily for cross section.
- Make sure hand operated 10 foot straightedges remove any discrepancies and bull float men remove straightedge marks.
- Assure the Final surface is finished with a burlap drag according to the Standard Specification requirements and is uniform in appearance. The Burlap drag should be raised when not in use.
- **Assure transverse grooves are uniform and of correct depth and width.**

36) Ensure that the curing is started as soon as possible while surface is moist. Immediately after the finishing operations have been completed and the surface water has disappeared, cure all surfaces of the pavement as soon as possible.
- Do not expose newly placed concrete pavement for more than 30 minutes before being covered on all exposed surfaces with curing compound. The 30 minutes may vary because of temperature and / or season.
- Membrane curing compound and other curing methods should be discussed and approved prior to use. The curing method used should be in accordance with Specification requirements.
- Ensure that the top and sides of slab are uniformly covered with curing compound, polyethylene film, or thoroughly wet burlap.

- Ensure the correct type of membrane curing compound is being used and that it has been pretested by the Materials and Tests Unit. If the compound is not pretested, submit a sample to the Materials and Tests Unit.
- Ensure the application machine is equipped with an agitator (compressed air or mechanical) and pump.
- Check for clean nozzles and uniform coverage of the slab, top and sides. Check for rate of coverage required by Standard Specifications (both mechanical and hand operated when used).

37) When Observing Joint construction, study the plans, Standard Specifications, Special Provisions, the Construction Manual, and the Construction and Inspection of Portland Cement Concrete Pavement Manual for all types and construct accordingly.
38) The Engineer or his representative when the initial or final cuts are made or when the joints are being filled with sealant shall observe the joint construction.
39) At least 20% of all joints should be measured for depth and noted for both the initial and final cuts.
40) Joints must be thoroughly clean and dry before sealing.
41) If necessary, the Engineer may request to have a representative of the silicone sealant manufacturer present on the project during sealing operations.
42) When paving adjacent to an existing slab, cover the transverse joint opening and crack of the existing slab with tape or other approved material to prevent intrusion of grout into the joint opening and crack.
43) When the slip form paving method is used, all applicable checks previously discussed above apply and in addition:
    - Ensure that adequate quantity of protective material is available including side forms or boards of proper dimension for temporary use.
    - Check the stringline or wireline for horizontal control periodically by eye.
    - Check trackline for grade and non-yielding surface.
    - Check slab thickness as recommended in Construction and Inspection of Portland Cement Concrete Pavement Manual.
    - Closely check on handwork necessary at the beginning and ending headers and that proper hand vibration is being done in these areas. Make certain there is no presence of dead concrete or excessive mortar. Make certain dowel bars, if required, are properly placed. Check for right angles from the longitudinal joint.
    - Check slump frequently when in superelevation and maintain minimum slump. The maximum edge slump is 1/4". Use edge forms, if unable to control edge slump.
    - Verify that concrete is placed within the time permitted by the Standard Specifications.
    - Transverse joints should match from lane to lane and lane to shoulder.
    - Check for proper grade to match bridge approach at least 160 feet from the approach.
    - Marks should be made for transverse joint locations for correct sawing location on the dowel baskets. Confirm that joint locations are marked at the same location as the dowel baskets. Check dowel bar assemblies for proper placement to assure that they are parallel with the base and centerline of the roadway and properly supported and staked.
    - Check the TR wires to see that they are cut.
    - Make sure dowel baskets are securely anchored on the bottom rail, BR wire, using the correct type, size, number, and length of staking pins.
    - Make sure that the M&T Section Specialist prior to use have checked dowel baskets and that the baskets are wax coated.

- Make sure that dowels are properly welded after they have been anchored (no loose bars).
- Check that the base material is maintained in a dampened condition ahead of the concrete placement.
- Observe the straightedge operations and bull float operations to see that the surface is flat and true.
- Make sure hand operated 10 foot straightedges remove any discrepancies and bull float men remove straightedge marks.
- Assure the Final surface is finished with a burlap drag and is uniform in appearance. The Burlap drag should be raised when not in use and should be used in a longitudinal direction.
- **Assure transverse grooves are uniform and of correct depth and width.**

44) Lastly, maintain the Technician's Daily Diary that includes hours, equipment, concrete temperatures, air content, slump, stations paved, width, weather, air temperatures, and problems encountered. Complete the M&T Form 252 R. Retrieve the 253 L & P and attach the 253 to the Technician's Daily Diary.

Maturity:

a) Contact the Construction Unit – Pavement Construction Section – for assistance when doing the Maturity Method. The NCDOT test method is available by contacting the Pavement Construction Section at 919-707-2400.

b) Verify that the Contractor has approved Maturity equipment and has a Maturity curve established in accordance with the Standard Specifications.

c) The Engineer or his representative will verify 10% of all verification tests done by the Contractor.

SECTION 710
CONCRETE PAVEMENT

710-1 DESCRIPTION

This section of the Specifications expands on the general requirements of Section 700 and gives the specific details and requirements for concrete pavement construction. While these Specifications will apply to most non-reinforced, jointed pavements with dowels, project personnel should always refer to the plans and Project Special Provisions for exceptions to the Standard Specifications.

710-2 MATERIALS

The specifications for concrete pavement materials are detailed in Division 10 of the Standard Specifications.

710-3 COMPOSITION OF CONCRETE

Concrete pavement mixes are designed by the Contractor and submitted through the Engineer to the Materials & Tests Unit for review and approval. Section 1000-3 of the Standard Specifications details the various requirements for these mixes and the supporting data that the Contractor must supply.

The Strength-Maturity curve should also be submitted with the Concrete Mix Design and the other required information (See 700-13 in the Standard Specifications).

Prior to submitting a proposed mix to the Materials & Tests Unit, the Engineer should satisfy himself that all of the information required for evaluating the mix has been furnished. On most concrete paving projects, more than one mix will be required due to the use of hand-placement methods, early strength requirements, or other factors. The Engineer should be thoroughly familiar with the requirements of the project and have readily available any information required relating to job mixes.

The Engineer and the Contractor should pay close attention to those quarries whose aggregates are known to exhibit ASR characteristics. These quarries are listed on the Materials and Tests Unit's website. When a concrete mix design contains aggregates from one of these listed quarries, the design should also include a pozzolan, such as fly ash, GGBFS, or Microsilica in the amounts listed in Article 1024-1, to inhibit the potential ASR problems.

The adjustment of mix designs when necessitated by low compressive strength is a critical factor, and the Engineer should notify the State Construction Engineer and Contractor immediately upon failure of the initial test beams to meet Specification requirements. The failure of a series of test cylinders to meet Specification compressive strength requirements at any time during production may indicate faulty testing procedures or a change in materials, and immediate checks and tests to determine the source of the deficiency should be made.

710-4 ACCEPTANCE OF CONCRETE

Acceptance testing and sampling of the concrete mix is the responsibility of the Engineer. The Contractor is required to furnish the materials to be sampled and tested. The Specifications outline several areas where the Engineer will perform acceptance testing.

Assistance in determining the correct procedures and frequency of testing can be found by contacting the Materials & Tests Unit or by contacting the Pavement Construction Section of the Construction Unit. Also refer to Article 700-15 for more details on compressive and flexural strength sampling and testing requirements.

When the average of the Department's compressive strength test results are below 4500 psi, the Engineer will perform an investigation..

710-5 CONSTRUCTION METHODS

Concrete pavement will be constructed in accordance with the provisions of Section 700.

Concrete pavement should be placed in 2-lane minimum widths; however, there are a few exceptions noted. Refer to the plan details for joint locations and spacing, lane widths, etc., when large areas of concrete pavement are to be constructed, such as parking lots, in rest areas, weigh stations, etc.

710-6 FINISHING

The concrete in front of finisher float machine screeds should be rolling, not sliding. (If not rolling, check to ensure that air-entrainment and slump meet specifications.) The first screed on the first pass should carry a uniform roll of concrete 6 to 8 inches in diameter and leave the concrete surface slightly high. The second screed on the first pass should carry a uniform roll of concrete 3 to 4 inches in diameter and cut the concrete to slightly above the level of the top of form. The forward screed should be tilted slightly to provide compaction and surge. Increasing the speed of transverse motion in relation to the forward motion usually eliminates tearing. Spreader and screeds shall operate continuously over the joints without disruption or lifting of the screed. For a good finish without bumps the paver should move continuously throughout the days operation with little or no stopping.

Experience has shown that supplemental finishing will be required for the concrete pavement to meet rideability requirements. This supplemental finishing may be accomplished either by an automated float attached to the paver or a tube machine. Except in areas not readily assessable to pavers and finishing machines, the use of straight edges for finishing operations shall be held to the minimum necessary. Proper finishing is the necessary step in the paving process in order to obtain the desired ride quality. The Technician should observe the Contractor's finishing methods and techniques so that he may be in a better position to insist on appropriate corrective action if the final surface testing described later in this section of the Manual indicates a need to do so.

The use of excessive water during the finishing operations will not be permitted as this may cause the top surface of the concrete to have a weaker strength and potentially scale or spall off early in the pavement's service life.

It is the Contractor's responsibility and the Department's objective to produce a quality pavement surface that will give a favorable ride **without** the use of grinding. Project personnel must insist that this objective be carried out by the Contractor even if it means stopping the paving operation until the problem can be corrected. When necessary, the Engineer should notify both the Division Engineer and the State Construction Engineer. The Contractor should not be allowed to continue paving when poor rideability is being achieved or excessive grinding is being required.

The final operation to obtain the desired surface texture is that of grooving the surface. This involves the movement of steel tines transversely across the pavement surface while it is

still in a plastic state in order to scratch small grooves in the pavement surface. This will improve the skid resistance of the pavement and reduce the hydroplaning affect to vehicles in inclement weather by providing channels for the surface water to run off the pavement surface toward the shoulders. The PCCP Roadway Technician should monitor this tining operation to ensure that the Contractor's timing for performing the transverse grooving is appropriate to achieve the desired results. If the Contractor is attempting to tine the pavement too early, the steel tines will have a tendency to drag some aggregate out of the surface, or the depth of the tines will be greater than the required depth. Conversely, if the tining is done too late, the grooves may not be deep enough and grinding of the pavement will be required to provide enough skid resistance. In addition, checks should be made to prevent the overlapping of adjacent grooving and to minimize the blank areas between passes. The Technician should refer to the plans and/or standard drawings for specific details on tine dimensions, location relative to edge of pavement, etc.

The Contractor will provide a textured surface with an average texture depth of 0.8 mm as tested in accordance with ASTM E 965 (*Test Method for Measuring Pavement Macrotexture Depth Using a Sand Volumetric Technique*) with no single test having a texture depth of 0.5 mm or less.

The Contractor will perform four randomly located tests in accordance with ASTM E 965 within the initial pavement lot of each mobilization and provide test results to the Engineer. A lot is defined in Article 710-4. If the average of the four tests does not meet the above criteria, make appropriate changes to the surface texture operations and test the next lot as detailed above. Once the surface texture process is established to meet minimum texture requirements, maintain consistency within the operation to provide the above minimum texture depth. Perform additional sand patch tests in accordance with ASTM E 965 when directed.

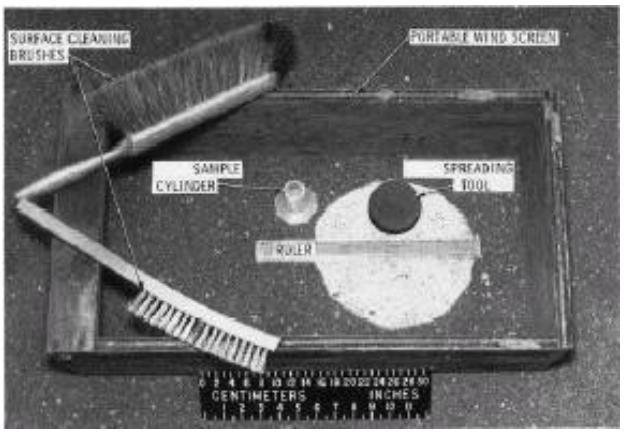
Should the surface texture become damaged or reduced by rain, grinding or any other action, reestablish or restore surface texture by an approved method.

Once the pavement has hardened, checks of the tining depth can be made to determine compliance with Article 710-6 describes the procedure required to check the depth of the texture.

The depth of the texture is important. The grooves are constructed to break the plain surface and thereby prevent hydroplaning. But, the grooves can create a noise problem.

In order to minimize the noise from the pavement surface, the tine depths shall be as shallow as possible within the specifications. This will insure safety but minimize any objectionable noise.

The apparatus needed to perform ASTM E 965, "Test Method for Measuring Pavement Macrotexture Depth Using a Sand Volumetric Technique" is as follows:



- Container for Glass Spheres
- Sample cylinder (35mm film container)
- Ruler
- Spreading Tool (Hockey Puck)
- Surface Cleaning Brushes (Wire Brush, Soft Bristle Brush)
- Small Straightedge (small spatula)
- Portable Wind Screen

Procedure:

Begin by selecting four randomly selected test areas in each lot (same stations as strength, and thickness cores). Note: The same technician should perform all the testing.

1. Inspect the test area to be measured. Test area must be a dry homogeneous area that contains no unique, localized features such as cracks or joints.
2. Thoroughly clean the surface with the stiff wire brush to remove any residue and then with the soft bristle brush remove any of the residue, debris, or loosely bonded aggregate particles from the test surface.
3. Position the portable wind screen around the test area.
4. Fill the small sample cylinder of known volume with the glass spheres and gently tap the base of the cylinder several times on a rigid surface. Add more material to fill the cylinder to the top and level with a straightedge. If a set of laboratory scales are available, determine the mass of material in the cylinder and use this mass of material sample for each measurement.
5. Pour the measured volume or weight of material onto the cleaned test surface within the area protected by the portable wind screen.
6. Carefully spread the glass spheres into a circular patch with the spreading tool (hockey puck), rubber side down, filling the surface voids flush with the aggregate particle tips.
7. Measure and record the diameter of the circular area covered by the glass spheres at a minimum of four equally spaced locations, such as 0°- 180°, 45° - 225°, 90° - 270°, 135° - 315°, around the circumference.
8. Compute and record the average diameter of the circle.

Calculation:

- Cylinder Volume:
  - Calculate the internal volume of the sample container as follows:

$$V = \frac{\prod d^2 h}{4}$$

Where:
V = internal cylinder volume, in^3, (mm^3)
d = internal cylinder diameter, in. (mm), and
h = cylinder height, in. (mm).

- $MATX_d$ or Average Macro Texture Depth
  - Calculate the average macro texture depth as follows:

$$MATX_d = \frac{4V}{\prod D^2}$$

Where:
$MATX_d$ = Mean texture depth of pavement macrotexture, in. (mm).
V = sample volume, in^3, (mm^3), and
D = average diameter of the test area covered by the glass spheres, in. (mm).

An example of one test area location for calculating the mean texture depth of the pavement macrotexture is below:

Volume of glass spheres, V:_____ mm^3

Dia. 1: _____ mm Dia. 2 _____ mm Dia. 3: _____ mm Dia. 4: _____ mm

Average Diameter, D_{avg}: ☐ mm

Avg. Macro Texture Depth $MATX_4$ _____ mm

710-7 FINAL SURFACE TESTING

The Specifications require the Contractor to use an approved Inertial Profiler to determine the longitudinal profile and localized roughness of the concrete pavement surface. . The Contractor and/or the Engineer should contact the Pavement Construction Section when smoothness testing is to begin.

The profiler must be operated by a competent operator, typically representing the Contractor, in the presence of the Engineer or his representative from the Department. The profiler will produce data, compatible with the latest version of FHWA's ProVAL (Profile Viewing and Analysis) software. After the Contractor has completed smoothness testing, data will be furnished to the Engineer immediately and produce a report within 10 days after completion of the smoothness testing. The report will include electronic files compatible with ProVAL and evaluation in tabular form with each 0.1 mile segment occupying a row. Each row should include the beginning and ending station for each section, the length of the section, the original IRI values from each wheel path, and the MRI value for each section. Each continuous run for a section will occupy a separate table and each table will have a header that includes the following:

1) The project contract number
2) County
3) The roadway number or designation
4) A lane designation
5) The dates of the smoothness runs
6) The beginning and ending station of the continuous run.

Summarize each table at the bottom.

The Specifications establish limits on smoothness with an International Roughness Index (IRI) expressed in inches per mile and localized roughness that cannot exceed an IRI of 125 inches/mile at the continuous short interval of 25 feet. The Contractor will be responsible for computing the IRI and MRI for each 0.1 mile section length and noting any localized roughness greater than 125inches/mile in any continuous short interval of 25 feet that will need repair. If any section of pavement does not meet the applicable specification requirements, over 90 IRI corrective action will be required.

The method used to compute the International Roughness Index (IRI) is given in the procedure titled, **Determination of International Roughness Index Using an Inertial Profiler is** located in the Construction and Inspection of Portland Cement Concrete Pavement Manual. Copies of this procedure can be obtained from the Pavement Construction. The Pavement Construction Engineer can also provide assistance in determining how to use ProVAL and interpret the IRI information.

While a **minimal** amount of grinding may be required to correct a few deficiencies in the pavement surface, excessive grinding as a means to improve ride quality shall not be permitted. Therefore, it is necessary for the Engineer to require the Contractor to begin the surface testing of the concrete pavement as soon as possible. Should the Contractor be producing concrete pavement that fails to meet the rideability Specification requirements, the Engineer should advise the Contractor that extensive grinding to correct these problems will not be permitted and that the Contractor shall undertake to correct whatever methods, equipment, materials, and/or workmanship that may be required to correct the situation. The Contractor shall not be permitted to continue paving as long as he is producing out of Specification pavement. The Contractor's paving operations shall be immediately stopped by the Engineer until the problems are corrected, and the Contractor can construct a concrete pavement that meets the rideability requirements

with minimal or no grinding. The Construction Unit shall be apprised of the need to suspend the Contractor's operations in order to gain compliance with the rideability requirements.

The payment for surface testing is full compensation for the Contractor furnishing, maintaining, and operating the profiler and any necessary equipment. Also included in the unit price are graph paper and any other materials or supplies that are necessary to satisfactorily complete the surface testing.

710-8 PAVEMENT MARKING

The Contractor must press metal dies having beveled faces into the fresh concrete along the outside shoulder to mark the stations of the project. The Stations should be marked in accordance with the plans and Standard Drawing No. 710.01. In addition to the station markings, the location of all shoulder drain outlets and underground utility crossings shall be marked on the pavement edge nearest the outlet. The location of the shoulder drain outlet or drainage structure containing the drainage outlet should be marked perpendicular.

710-9 THICKNESS TOLERANCES

The determination of pavement thickness for acceptance is determined by the measurement of cores tested in accordance with AASHTO T 148 as modified by the Department. The Engineer will select and locate the random locations for core samples. The Contractor shall core the selected locations in the presence of the Engineer. The Engineer shall deliver the samples to the Materials & Tests Unit, which will measure the samples and report the results.

The thickness measurements are reported to the State Roadway Construction Engineer who makes the final determination under the provisions of Article l05-3 of the Standard Specifications as to any reduction in payment that may be necessary for deficient pavement thickness.

This article also provides the allowable tolerance for pavement thickness and the sanctions for deficient depth. Payment shall be made based on the thickness reported in accordance with Article 710-11.

710-10 MEASUREMENT AND PAYMENT

(A) GENERAL

This article describes the method of measurement of concrete pavement. Separate measurement will be made for pavement lots, which are deficient in either thickness or compressive strength or both. This article also covers payment of Surface Testing Concrete Pavement.

(B) PAVEMENT DEFICIENT IN THICKNESS

This article covers details of the method of payment for lots deficient in the thickness of Portland Cement Concrete pavement. Pay factors are covered from 0.2" to 1.00" and if pavement is deficient by more than 1.0".

(C) CONCRETE PAVEMENT VARYING IN STRENGTH

This article covers details of the method of payment for lots deficient in compressive and flexural strength of Portland Cement Concrete pavement.

1. The pay factor for pavement achieving a compressive strength in 28 days of 4500 psi or greater is 100%. The pay factor for pavement achieving compressive strengths ranging from 4500 psi to 3000 psi is calculated using the formula below.

   PAY FACTOR % = 100.0 – [0.05 x (4,500 – Compressive Strength)]
   (pay factor is rounded to the nearest tenth of one percent)

2. The pay factor for pavement achieving a flexural strength in 28 days of 650 psi or greater is 100%. The pay factor for pavement achieving flexural strengths ranging from 650 psi to 600 psi at 28 days is calculated using the formula below.

   PAY FACTOR % = 100.0 – (650 psi – PSI)
   (pay factor is rounded to the nearest tenth of one percent)

(B) MULTIPLE ADJUSTMENTS IN PRICE

This article covers pavement lots found to be deficient in both thickness and strength.

TECHNICIAN'S CHECKLIST
SECTION 710
CONCRETE PAVEMENTS AND SHOULDERS

1) Ensure texturing is properly performed at the appropriate time.
2) Check that the texture marks are uniform and parallel to the centerline.
3) Verify texture by texture testing and observing the Contractor's operations.
4) Check that the tines have proper random spacing, width, and are applied at the proper depth.
5) Determine the locations of thickness cores using random numbers.
6) Observe the Contractor's coring operations to verify authenticity.
7) The Contractor furnishes all necessary equipment – Inertial profiler - and supplies for final surface testing. The Contractor operates the profiler with a competent operator and conducts test in presence of the Engineer within 7 days after receiving authorization to perform testing. .
8) Observe calibrations of profiler at the beginning of each day's operation to ensure that vertical deviations and horizontal distances are being recorded accurately.
9) Retrieve raw data from the Contractor immediately after surface testing is complete on an approved media. Data should be compatible with the latest version of ProVAL.
10) Verify the Contractor's International Roughness Index (IRI) by using the latest version of ProVAL and note all localized roughness as described in the Construction and Inspection of Portland Cement Concrete Pavement Manual.
11) Immediately notify the Engineer when the requirements for final surface testing are not met.
12) Verify the Station marking and shoulder drain outlet locations are stamped in the pavement according to plans and Specifications.

SECTION 720
CONCRETE SHOULDERS

720-1 DESCRIPTION

This section of the Specifications addresses the construction of concrete shoulders. Concrete shoulders are constructed in accordance with the general requirements of Section 700 and the specific requirements included in this section.

720-2 MATERIALS

Concrete shoulders are constructed of the same quality concrete as required in the concrete pavement. The material requirements are detailed in Division 10 of the Standard Specifications.

720-3 COMPOSITION OF CONCRETE

Refer to Article 710-3 of this Manual and Section 1000-3 of the Specifications for details.

720-4 ACCEPTANCE OF CONCRETE

Acceptance sampling and testing of the concrete mix for shoulders is the responsibility of the Engineer. The Contractor is required to provide process control and to furnish the materials to be sampled and tested. The Engineer will determine the extent of each lot for compressive strength and thickness testing.

Assistance in determining the correct procedures and frequency of testing can be obtained by contacting the Materials & Tests Unit or by contacting the Pavement Construction Section of the Construction Unit.

720-5 EQUIPMENT

Equipment used in the construction of the concrete shoulders shall meet the requirements of Sections 700 and 1000 of the Standard Specifications. Where slipform pavers are used to place the concrete shoulder, they shall operate on fixed continuous reference lines for both horizontal and vertical control, except when approved by the Engineer. The previously placed mainline concrete pavement surface may be used in conjunction with a mobile ski/stringline device. The Specifications do allow for the waiver of this requirement; however, the State Roadway Construction Engineer should be consulted prior to approving such a request.

720-6 CONSTRUCTION METHODS

The concrete shoulder will normally be supported by both the exposed portion of the base and the earth shoulder. It is, therefore, extremely important that specification density be achieved in the earth portion of the paving platform such that stresses caused by settlement of the shoulder are not induced into the concrete shoulder. The end result of such stresses may be extensive cracking of the shoulder concrete. Also, the Technician should be mindful of the fact that the base and the adjoining concrete pavement edge need to be clean before placing the shoulder concrete.

The spreading and finishing of the mix is similar to that of concrete pavement construction. The shoulder typical sections should be frequently reviewed and adjustments made to the equipment where required, such that the desired slope, cross-sectional shape, and minimum thickness of the shoulder is achieved.

Use a curing period of three curing days for straight cement mix designs and seven curing days for pozzolan mix designs. A curing day is any consecutive 24-hour period beginning with the mixing of the concrete when the air temperature next to the shoulder does not fall below 40°F. During cool periods, a hi-low thermometer and maturity meters should be used to keep a daily check on the temperature beneath the protective covering and near the corners of the PCC pavement. These readings shall be recorded in the project diary. No traffic, construction or otherwise - except for the purpose of sawing joints will be allowed on the shoulder until the completion of the curing period.

720-7 FINISHING

Finishing of concrete shoulders is similar to that of concrete pavement, except that the final finish is accomplished by burlap dragging or brooming rather than with metal tines.

720-8 JOINTS

The Specifications require that joints in the concrete shoulder match the joints of the concrete pavement. Dowels are typically not required on the transverse joints in the concrete shoulders unless otherwise specified in the plans. Refer to Articles 700-11 and 700-12 of this Manual for joint construction and sealing requirements.

720-9 THICKNESS TOLERANCES

The Engineer will determine the random locations of core samples for the determination of shoulder pavement thickness. The Contractor shall core the selected locations in the presence of the Technician. The Engineer will deliver the samples to the Materials & Tests Unit, which will measure the samples and report the results. The State Construction Engineer will make, in accordance with the provisions of Article 105-3, the final determination as to shoulder depth acceptability, and will also determine appropriate pay factors where necessary. The Engineer should be prepared to assist the Materials & Tests Unit in determining the theoretical shoulder thickness at each core location. The Materials & Tests Unit shall make the comparison between the actual and theoretical thickness and will compute the average deviation for the project. Upon receipt of this final determination, test results and pay factors from the Construction Unit, the Engineer shall notify the Contractor of the results.

720-10 MEASUREMENT AND PAYMENT

This article describes the method of measurement of concrete shoulders. Separate measurement will be made for pavement lots, which are deficient in either thickness or compressive strength or both.

This article also describes in detail the basis of payment for various concrete shoulder items. Also included are the procedures for computing and applying price adjustments for pavement deficient in thickness, pavement compressive strength variability and deficiency, and for multiple deficiencies.

SECTION 725
FIELD LABORATORY FOR
PORTLAND CEMENT CONCRETE PAVEMENT

725-1 DESCRIPTION

The provisions of this section of the Specifications are explicit and the Engineer should ensure that, within reason, all of the requirements are met. Judgment may be applied, but the intent of this section is that the Contractor shall provide an adequate facility and receive rental for its use. Payment for the field laboratory represents full compensation for the Contractor's furnishing a curing shelter or lime-water tank at his discretion.

725-2 GENERAL REQUIREMENTS

This section describes in detail the requirements for the field laboratory. The Engineer should contact the Materials & Tests Unit and/or the Pavement Construction Section for assistance in approving the laboratory and equipment, if needed.

725-3 COMPENSATION

This article describes the method to be used in making partial payments and final payment for the Field Lab Rental.

TECHNICIAN'S CHECKLIST
SECTION 700
PORTLAND CEMENT CONCRETE PAVEMENT
PART 1 - PLANT INSPECTION

A. Study Specifications, plans, and Special Provisions.
B. Plant Inspection - General
   1) The Field laboratory and curing shelter or tanks should be located as close to the plant and stockpiles as is reasonable.
   2) Run moisture tests on the aggregates each morning before paving operation begins and as often thereafter as necessary, adjusting weights of aggregates accordingly.
   3) Complete M&T Form 253 and submit daily to Pavement Construction Engineer.
   4) Sample each car of cement or each fourth truck tanker shipped by truck and submit sample to the Physical Testing Laboratory of the Materials & Tests Unit.
   5) Test each car of cement or each fourth truck tanker to assure that cement does not already contain air-entraining agent.
   6) Check amount of air-entraining agent according to test run by Roadway Technician.
   7) Check air-entraining dispenser at least once each morning and once each afternoon.
   8) The Plant Technician is to make cure and test concrete beams, in accordance with the procedures given in the Construction and Inspection of Portland Cement Concrete Pavement Manual.
   9) A check list of some of the items to be observed with relation to aggregate stockpiles is as follows:
      a) The stockpiled area should be cleaned of vegetation, well drained, and covered with a layer of aggregate.
      b) The material, when handled by clam bucket or conveyer belt, should not be allowed to drop free for any appreciable distance.
      c) Avoid inclusion of foreign material when cleaning up stockpile.
      d) Avoid use of tractor vehicles on large aggregate stockpiles.
      e) Maintain space between stockpiles and in limited areas use bulkheads.
      f) Make visual examination of stockpiles several times daily.
      g) Do not permit the use of alternate wet and dry materials direct from the quarry. All worked aggregate shall be stockpiled either at the producer's plant or the job site for at least 24 hours prior to being used.
   10) The plant must be certified.
   11) The plant technician must be certified.
C. Specific requirements for batch plant inspection.
   1) Materials must be accurately weighed.
   2) All batch-weighing equipment should be placed on concrete footings.
   3) Scales shall be calibrated by a registered or licensed scale mechanic and an appropriate stamp of inspection shall be on the scales.
   4) At intervals of about one hour, the Plant Technician should visually check scales to see if they balance at zero.
   5) Other items to be checked are:
      a) Scales must be kept level.
      b) All working parts must be cleaned.
      c) Never oil working parts.
      d) Require canvas trunk on cement hopper.

6) All batch trucks must be checked for compliance to Specifications before being permitted on the project.

D. Specific requirements for central mixed plant inspection.
   1) Principal points to be observed:
      a) Mixing blades not worn down more than 10 percent
      b) Water system tested
      c) Mixing time
      d) Valves checked for leakage
      e) Mixer checked frequently for buildup of concrete around blades
      f) Air-entraining dispenser checked, all piping clean and air vent open
      g) Size of batch, speed of rotation, and mixing cycle in compliance with Specifications
   2) Time from batching of concrete to placement shall not exceed the Specification requirements.

E. Specific requirements for batch plant and truck mixer inspection.
   1) Refer to Division 10 of the Specifications.

TECHNICIAN'S CHECKLIST
SECTION 700
PORTLAND CEMENT CONCRETE PAVEMENT
PART II - ROADWAY INSPECTION

A. Study Specifications, plans, and Special Provisions.
B. Preparation of subgrade and base:
   1) Automatic fine grade machine may be required by Specifications.
   2) Refer to the applicable sections of Divisions 5 and 6 as appropriate for preparation of subgrade or base.
   3) Make frequent checks for conformity to line, grade, and typical sections.
   4) Discuss necessity for grade adjustment with Engineer.
   5) If grade adjustments are made, advise other Technicians.
   6) Check line and grade at structures carefully.
   7) Do not permit hauling equipment on base course except as may be allowed by the Specifications.
   8) Final riding surface of pavement dependent upon quality of subgrade and base surface - be alert.
C. Forms:
   1) Ensure that construction and condition are in accordance with Specifications prior to use.
   2) Set sufficiently in advance of paving to allow inspection.
   3) Uniformly supported and tamped
   4) Locks securely fastened
   5) Pins securely locked in stake pockets
   6) Correct distance from centerline
   7) Correct width between forms
   8) Forms on each side at correct elevation
   9) True to smooth line and grade - checked by eyeing in top of form
   10) Removal prior to 12 hours after concrete placed not permitted
   11) Damage to edge of slab and honeycomb repaired immediately and before curing compound is applied.
   12) Proper curing of edges when forms are removed.
D. Paver Mixing:
   1) Check drum revolutions per minute several times daily and record in diary.
   2) Water discharge calibrated and valves checked daily for leakage.
   3) Check inside mixer drum for worn blades or built up concrete.
   4) Check mixing time for compliance with Specifications and record in diary.
   5) If water adjustment is necessary, advise Plant Technician immediately.
   6) If mix is not of proportion by visual inspection, advise Plant Technician and check for reason.
E. Placing Concrete:
   1) Check ahead with base course, form, and density Technicians to anticipate any difficulty.
   2) Check subgrade with scratch template and string line and rule. Record results of stringline check on at least 50 intervals.
   3) Forms thoroughly oiled.
   4) Base course moistened before placing concrete.
   5) Concrete spreading easily without segregation giving even spreading and uniform strikeoff. If not, check for reason.

6) Dowels, tie bars, joint assemblies all according to plans and Specifications.
7) The Contractor should be reminded that all equipment speeds must be adjusted to match the slowest operation.
8) Perform slump tests and air entrainment tests at the required frequency. Keep Plant Technician informed.
9) Assist Roadway Technician in making test cylinders and if necessary, assist Laboratory Technicians with making test beams.
10) Station marking and shoulder drain outlet locations placed according to plans and Specifications.
11) Protection from cold weather and rain as required by Specifications adhered to by Contractor.

F. Spreading and Vibrating:
1) Use minimum adequate vibration.
2) Vibrators checked by the Pavement Construction Engineer's representative before use and as necessary by observation for conformity to Specifications.
3) Check electronic vibration monitoring device several times daily. Contractor to provide reports as per the Standard Specifications (Article 700-6)
4) Check mortar depth on surface with index finger. If more than 3 mm (1/8 inch) may be due to over vibration.
5) Concrete in front of screeds rolling (if not, check air and slump).
6) Screeds carrying uniform roll.
7) Forward screed tilted slightly to provide compaction and surge.

G. Finishing:
1) Check top of slab with string line and rule using uniform sized blocks set on top of forms several times daily for cross section.
2) Make sure hand operated 3 meter (10 foot) straightedges remove any discrepancies and bull float men remove straightedge marks.
3) Slab edged along forms to proper radius.
4) Final surface finish with burlap drag according to Specification requirements and uniform. Burlap drag raised when not in use.
5) Assure transverse grooves are uniform and of correct depth and width.

H. Final Surface Testing:
1) Contractor furnishes an approved inertial profiler and competent profiler operator.
2) Contractor furnishes all necessary equipment and supplies and conducts test in presence of the Engineer or his representative no later than 7 days after receiving authorization to start smoothness testing.
3) Observe the calibration of profiler at the beginning each day's operation (as a minimum) to ensure that vertical deviations and horizontal distances are being recorded accurately.
4) If specification requirements for rideability are not met, the Technician shall immediately notify his Engineer who may contact the Construction Unit for further guidance.
5) Retrieve raw data from the operator immediately after smoothness testing is completed for a day’s run. The operator should supply all data on approved media (CD-R, DVD-R, or “flash drive”) which will not be returned.
6) Engineer computes the International Roughness Index (IRI) to verify Contractor’s results and notes all bumps that exceed the localized roughness part of the specifications.
7) Contractor will submit documentation and electronic data of the evaluation of each section within 10 days after completion of the smoothness testing per the Standard Specifications.

I. Curing:
   1) Started as soon as possible while surface is moist.
   2) Top and sides of slab uniformly covered.
   3) Membrane curing compound:
      a) Correct type and pretested or submit sample
      b) Application machine to be equipped with agitator (compressed air or mechanical) and pump.
      c) Check for clean nozzles and uniform coverage. Check for rate of coverage required by Specifications (both mechanical and hand operated when used).
   4) Other curing methods should be discussed and approved prior to use and then one in accordance with Specification requirements.

J. Joints:
   1) Study plans, Specifications, standard plans, Special Provisions, and the Construction Manual for all types and construct accordingly.
   2) Must be clean and dry before sealing.
   3) Sealed in accordance with Specifications. Sealing equipment operated in accordance with manufacturer's recommendations.

K. Slip form paver method:

L. When this method is used, all applicable checks previously listed apply and in addition:
   1) Become familiar with equipment to be used.
   2) Ensure that adequate quantity of protective material is available including side forms or boards of proper dimension for temporary use.
   3) Check wire line for horizontal control periodically by eye.
   4) Check track line for grade and non-yielding surface.
   5) Check slab thickness as recommended in Manual.
   6) Close check on handwork necessary at beginning and ending headers and proper hand vibration.
   7) Check slump frequently when in superelevation and maintain minimum slump. Use edge forms if unable to control edge slump.
   8) Observe carefully the making of the header when paving is stopped. Make certain there is no presence of dead concrete or excessive mortar. Check adequacy of hand vibration adjacent to the header. Make certain dowel bars, if required, are properly placed.